AIR QUALITY MONITORING CONSIDERATIONS FOR THE NORTHEAST COASTAL AND BARRIER NETWORK

April 2002

Introduction

The NPS Air Resources Division (ARD) contracted with the University of Denver (DU) to produce GIS-based maps and an associated look-up table that provide baseline values for a set of air quality parameters for all Inventory and Monitoring parks in the U.S. These maps and table will serve as the Air Quality Inventory for the parks. ARD used preliminary DU products to help develop a strategy for expanding NPS ambient air quality monitoring with increased funding from the Natural Resources Challenge. At this time, ARD does not intend to fund additional monitoring at any NPS units in the Northeast Coastal and Barrier Network. The air monitoring strategy will be revisited in FY 2004 if additional funding becomes available. Draft Air Quality Inventory products are available on the NPS Intranet (at http://www2.nrintra.nps.gov/ard/ under "Air Atlas") and are provided in an attachment to this report. Final products will be available on the NPS Internet in a few months.

Data from the Air Quality Inventory, national air monitoring programs described below, and other air quality sources, were used in conjunction with park-specific resource information to evaluate the following needs relative to the Northeast Coastal and Barrier Network: 1) the need for additional ambient air quality monitoring at any Network park, i.e., wet deposition, dry deposition, visibility, and/or ozone monitoring, and 2) the need for air quality effects-related monitoring at any Network park. The results of this evaluation, as well as a brief summary of results of past air quality monitoring at relevant sites, are discussed below.

Wet Deposition

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) is a nationwide network of precipitation monitoring sites. The network is a cooperative effort between many different groups, including the U.S. Environmental Protection Agency (EPA), U.S. Geological Survey, U.S. Department of Agriculture, and private entities. The NPS is a major participant in NADP/NTN, and the ARD recommends that any new wet deposition site installed in a park meet NADP/NTN siting criteria and follow NADP/NTN protocols. There are currently more than 200 NADP/NTN sites spanning the continental U.S., Alaska, Puerto Rico, and the Virgin Islands.

The purpose of the network is to collect data on the chemistry of precipitation to monitor geographical and temporal long-term trends. The precipitation at each station is collected weekly according to strict clean-handling procedures. It is then sent to the Central Analytical Laboratory in Illinois where it is analyzed for hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and base cations (such as calcium, magnesium, potassium and sodium). NADP/NTN's excellent quality assurance programs ensure that the data remain accurate and precise. The National Atmospheric Deposition Program has also expanded its sampling to include the Mercury Deposition Network (MDN), which currently has over 35 sites. The MDN was formed in 1995 to collect weekly samples of

precipitation, which are analyzed for total mercury. The objective of the MDN is to monitor the amount of mercury in precipitation on a regional basis.

Two of the eight Northeast Coastal and Barrier Network units currently have a NADP/NTN monitor on-site (Assateague Island National Seashore (NS) and Cape Cod NS); the rest of the parks have a monitor within 85 miles. Many of the closest NADP/NTN monitors are inland of the parks. The distance to, and location of, these NADP/NTN sites is problematic, because in coastal areas, there can be substantial differences in wind patterns, and localized meteorology may significantly affect pollutant deposition. The Wye, Maryland, site is probably representative of George Washington Birthplace National Monument (NM) and Thomas Stone National Historic Site (NHS). However, existing wet deposition monitoring may not be adequate for Colonial National Historical Park (NHP), or for the three units in New York City--Gateway National Recreation Area (NRA), Fire Island NS, and Sagamore Hill NHS. A NADP/NTN wet deposition site costs $5,000 to $8,000 for equipment purchase and installation, and operating costs (including site operation, chemical analysis, and reporting) are about $7,000 per year. The Network may want to consider conducting wet deposition monitoring in Colonial NHP or in a New York City park if eutrophication is a concern.

There are no MDN sites located near parks in the Northeast Coastal and Barrier Network. The closest sites are in Freeport, Maine (site #ME96); Milford, Pennsylvania (site #PA72); and Pettigrew State Park, North Carolina (site #NC42). The NPS will be installing a MDN site in Shenandoah NP in FY2003. Adding mercury sampling to a NADP/NTN site increases annual costs by about $3,000.

Deposition varies with the amount of annual on-site precipitation, and is useful because it gives an indication of the total annual pollutant loading at the site. Concentration is independent of precipitation amount, therefore, it provides a better indication of whether ambient pollutant levels are increasing or decreasing over the years. In general, annual average wet deposition and concentration of sulfate, nitrate, and ammonium are higher in the eastern than in the western U.S. (see attached Draft Air Inventory maps and NADP/NTN maps at http://nadp.sws.uiuc.edu). At many NADP/NTN sites across the U.S., concentration and deposition of sulfate have declined in recent years as sulfur dioxide emissions have decreased. Trends have been variable for nitrate and ammonium, with concentration and deposition at various sites increasing, decreasing, or showing no overall change. Results from NADP/NTN sites in and near Northeast Coastal and Barrier Network parks are summarized below.

Cape Cod, MA

The Cape Cod, Massachusetts, NADP/NTN site (site #MA01 (North Atlantic Coastal Laboratory)) was installed in 1981. To date, site data have not met the completeness criteria required for NADP/NTN to perform trend analyses. However, a review of site data suggests a decrease in concentration and deposition of wet sulfate.

Wye, MD

The Wye, Maryland, NADP/NTN site (site #MD13) has been operating since 1983. Site data show a decrease in concentration and deposition of wet sulfate; a slight decrease in concentration of wet nitrate; and no overall trend in wet nitrate deposition, wet ammonium concentration, or wet ammonium deposition.

Assateague Island NS, MD

The Assateague Island NS, Maryland, NADP/NTN site (site #MD 18) was installed in September 2000. Trend data are not yet available for the site.

Edwin B. Forsythe NWR, NJ

The Edwin B. Forsythe National Wildlife Refuge, New Jersey, NADP/NTN site (site #NJ00 (Brigantine)) was installed in 1998. Trend data are not yet available for the site.

Pennington, NJ

Pennington, New Jersey, has had an NADP/NTN site (site #NJ99 (Washington Crossing)) since 1981. Site data show a decrease in concentration and deposition of wet sulfate; no overall trend in concentration and deposition of wet nitrate; and no overall trend in concentration and deposition of wet ammonium.

West Point, NY

The West Point, New York, NADP/NTN site (site #NY99) was installed in 1983. Site data show a decrease in concentration and deposition of wet sulfate; a decrease in concentration and deposition of wet nitrate; and an increase in concentration and deposition of wet ammonium.

Prince Edward County, VA

An NADP/NTN site was installed in Prince Edward County, Virginia (site #VA24) in 1999. Trend data are not yet available for the site.

Dry Deposition

The Clean Air Status and Trends Network (CASTNet) is considered the nation's primary source for atmospheric data to estimate dry acidic deposition. Established in 1987, CASTNet now comprises over 70 monitoring stations across the U.S. The majority of the monitoring stations are operated by EPA; however, approximately 20 stations are operated by the NPS in cooperation with EPA. Each CASTNet dry deposition station measures: weekly average atmospheric concentrations of sulfate, nitrate, ammonium, sulfur dioxide, and nitric acid; hourly concentrations of ambient ozone; and meteorological conditions required for calculating dry deposition rates. Dry deposition rates are calculated using atmospheric concentrations, meteorological data, and information on land use, vegetation, and surface conditions. CASTNet complements the database compiled by NADP/NTN. Because of the interdependence of wet and dry deposition, NADP/NTN wet deposition data are collected at or near all CASTNet sites. Together, these two long-term databases provide the necessary data to estimate trends and spatial patterns in total atmospheric deposition. The ARD recommends that all new dry deposition sites installed in parks use CASTNet siting criteria and follow CASTNet protocols.

None of the Northeast Coastal and Barrier Network parks have a CASTNet monitor on-site; all have a monitor within 100 miles. As with the NADP/NTN sites, distance to, and direction from, parks may limit the usefulness of the CASTNet data. The Blackwater NWR, Maryland, data are probably adequate for Assateague Island NS, George Washington Birthplace NM, and Thomas Stone NHS. The other parks likely do not have representative CASTNet data. Nevertheless, given the expense of dry deposition monitoring, unless there is a particular need to quantify dry deposition in a park, the ARD does not recommend the Network fund CASTNet monitoring. Installation and annual operating costs for a CASTNet site are about $50,000 and $15,000, respectively.

Because CASTNet uses different monitoring and reporting techniques than NADP/NTN, the dry deposition amounts are reported here as nitrogen and sulfur, rather than nitrate, ammonium, and sulfate. In addition, because CASTNet calculates dry deposition based on measured ambient concentrations and estimated deposition velocities, there is greater uncertainty in the reported values. Due to the small number of CASTNet sites nationwide, use of dry deposition isopleth maps is not advised at this time. CASTNet data collected near Northeast Coastal and Barrier Network parks is summarized below.

Abington, CT

The Abington, Connecticut, CASTNet site (site #ABT147) has been in operation since 1993. There have been decreasing trends in both dry nitrogen and dry sulfur deposition at the site. Total nitrogen deposition at Abington is composed of 24 percent dry deposition and 76 percent wet deposition, while total sulfur deposition is 21 percent dry and 79 percent wet.

Blackwater NWR, MD

A CASTNet site has been operating at Blackwater NWR, Maryland, (site #BWR139) since 1997. Site data indicate a decrease in dry sulfur deposition, but no trend in dry nitrogen deposition. CASTNet estimates total nitrogen deposition at the site is composed of 39 percent dry deposition and 61 percent wet deposition, while total sulfur deposition is 42 percent dry and 58 percent wet.

Pennington, NJ

A CASTNet site has been operating at Pennington, New Jersey, (site #WSP144 (Washington Crossing)) since 1988. Site data indicate a decrease in dry sulfur deposition, but no trend in dry nitrogen deposition. CASTNet estimates total nitrogen deposition at the site is composed of 38 percent dry deposition and 62 percent wet deposition, while total sulfur deposition is 49 percent dry and 51 percent wet.

Prince Edward County, VA

A CASTNet site has been operating at Prince Edward County, Virginia, (site #PED108) since 1987. Site data show a decrease in dry sulfur deposition, but no trend in dry nitrogen deposition. CASTNet estimates total nitrogen deposition at the site consists of 35 percent dry deposition and 65 percent wet deposition, while total sulfur deposition is 33 percent dry and 67 percent wet.

Surface Water Chemistry
For most inland parks, the greatest concern relative to atmospheric deposition and surface water chemistry is acidification. For the parks in the Northeast Coastal and Barrier Network, the bigger concern is eutrophication from nitrogen (nitrate and ammonium) deposition. Because the Network already has a very knowledgeable team investigating the need to monitor eutrophication in various parks, the issue will not be addressed in this report.

Visibility
In 1985, in response to the mandates of the Clean Air Act, Federal and regional/state organizations established the Interagency Monitoring of Protected Visual Environments (IMPROVE) program to protect visibility in Class I air quality areas. Class I areas are national parks greater than 5,000 acres and wilderness areas greater than 6,000 acres, that were established prior to August 7, 1977. All other NPS areas are designated Class II. The objectives of the IMPROVE program are: to establish current visibility conditions in all Class I areas; to identify pollutants (particles and gases) and emission sources responsible for existing man-made visibility impairment; and to document long-term trends in visibility. In 1999, there were 30 official IMPROVE sites and 40 protocol sites. Because of recently enacted regulations that require improving visibility in Class I areas, the number of visibility monitors is increasing. Protocol sites are being upgraded to full IMPROVE sites and 80 new sites are being added to the IMPROVE network.

While the IMPROVE program has focused on Class I air quality areas, a great deal of visibility monitoring has been conducted in Class II areas. The ARD recommends that new visibility monitoring in NPS areas be conducted in coordination with the IMPROVE program (the IMPROVE program is managed out of the NPS ARD office in Fort Collins, Colorado). Installation and annual operating costs for a full IMPROVE site are about $15,000 and $30,000, respectively; however, partial monitoring, such as a camera-only site, is much less expensive.

There are, or soon will be, five IMPROVE sites in or near parks in the Northeast Coastal and Barrier Network. Massachusetts has been funding a protocol site at Cape Cod NS (site #CACO1). Other sites include a protocol site operated by Connecticut at Mohawk Mountain (site #MOMO1); Edwin B. Forsythe NWR, New Jersey (site #BRIG1), operating since 1991; the National Mall in Washington, D.C. (site #WASH1), operating since 1988; and a new site at Swanquarter NWR, North Carolina (site #SWAN1). Therefore, all parks in the Northeast Coastal and Barrier Network will have an IMPROVE monitor within 115 miles. This will be sufficient to provide a Network-wide assessment of visibility. If parks are interested in more site-specific monitoring, e.g., monitoring the plume from a nearby source, ARD can advise Network staff on how best to conduct this type of monitoring.

Not enough data have been collected and analyzed at these sites to detect long-term visibility trends (i.e., ten or more years). 1996-1998 data show that, as with previous years, standard visual range is substantially less in the eastern, than in the western, U.S. (see attached map). As for the sources of visibility impairment, 1996-1998 aerosol data

from Edwin B. Forsythe NWR and the National Mall are consistent with data from other eastern U.S. IMPROVE sites. These data show that, on an annual basis, visibility impairment is primarily due to sulfates (sources include coal combustion and oil refineries), then organics (sources include automobiles), then nitrates (sources include coal and natural gas combustion and automobiles), then light absorbing carbon (sources include wood burning), then soil (from windblown dust).

Ozone

Cape Cod NS has an ozone monitor on-site (site #250010002); the other parks in the Northeast Coastal and Barrier Network have one or more monitors within 30 miles. All parks except Assateague Island NS and George Washington Birthplace NM are in ozone nonattainment areas (see attached maps), meaning that the ozone levels in those areas exceed EPA's human health-based 8-hour National Ambient Air Quality Standard (NAAQS). Assateague Island NS and George Washington Birthplace NM are not in designated nonattainment areas because ozone is not monitored in those counties; however, based on high ozone concentrations in nearby counties, the NAAQS would be likely be exceeded at those parks, as well. In areas with high ozone concentrations, an ozone nonattainment designation can actually benefit the parks, because the designation requires the local or state air pollution control agency to take measures to reduce ozone levels. In case the Network is interested, installation and annual operating costs for an ozone monitoring site are about $90,000 and $14,000, respectively.

Vegetation

For vegetation, the focus is on ozone sensitivity because 1) ozone is a regional pollutant and is, therefore, more likely to affect park resources than other gaseous pollutants like sulfur dioxide and nitrogen oxide which quickly convert to other compounds, and 2) the literature on ozone sensitivity is more recent and more reliable than that for other pollutants. Park vascular plant lists contained in the April 2002 NPSpecies database were compared to the list of Very Ozone-Sensitive Plant Species contained in the NPS Synthesis information management system (see attached Synthesis species lists). The Synthesis lists were developed by an expert in the field of ozone effects on vegetation. Note that the Synthesis lists provide a general guide to ozone sensitivity. Differences in plant genetics, weather conditions, water availability, and ozone concentrations will affect whether or not a species exhibits injury in a particular park. Ozone sensitive species of natural vegetation were identified for seven of the eight parks in the Northeast Coastal and Barrier Network (see attached tables of sensitive species for Network parks). A vascular plant list for Thomas Stone NHS was not available in the NPSpecies database.

It is generally agreed that plant foliar injury occurs after a cumulative exposure to ozone. One ozone statistic that is used to evaluate the risk of plant injury is the SUM06. SUM06 is the sum of all hourly average ozone concentrations greater than or equal to 60 parts per million (ppm). In 1997, a group of ozone effects experts recommended 3-month, 8:00 a.m. to 8:00 p.m., SUM06 effects endpoints for natural vegetation, i.e., 8 to12 ppm-hrs for foliar injury to natural ecosystems and 10 to 15 ppm-hrs for growth effects on tree seedlings in natural forest stands. According to a SUM06 map generated by DU, all eight Northeast Coastal and Barrier Network parks have ozone concentrations, during some

years, that are high enough to harm native vegetation. Given this, Network staff may want to conduct foliar injury surveys on sensitive species. Good survey species are black cherry (*Prunus serotina*) and common milkweed (*Asclepias syriaca*) because 1) ozone injury symptoms for these species are well described and 2) standardized survey protocols and training manuals have been developed.

Conclusions

Two of the eight Northeast Coastal and Barrier Network units currently have a NADP/NTN monitor on-site. Existing monitoring may not be adequate for Colonial NHP, Gateway NRA, Fire Island NS, or Sagamore Hill NHS. Wet deposition monitoring may be desirable in parks where eutrophication is a concern.

None of the Northeast Coastal and Barrier Network parks have a CASTNet monitor on-site. Current monitoring is probably not adequate for Cape Cod NS, Colonial NHP, Gateway NRA, Fire Island NHP, or Sagamore Hill NHS. However, given the expense of CASTNet monitoring, installation of a dry deposition monitor is not recommended.

Cape Cod NS has an IMPROVE monitor on-site; the other seven parks in the Northeast Coastal and Barrier Network will soon have an IMPROVE monitor within 115 miles. This will be sufficient to provide a Network-wide assessment of visibility.

Cape Cod NS has an ozone monitor on-site; the other seven parks in the Northeast Coastal and Barrier Network have one or more monitors within 30 miles. Ozone monitoring is adequate for the parks. Six of the eight parks are in designated ozone nonattainment areas; the other two parks likely have exceedances of the NAAQS, as well.

Ozone sensitive vascular plant species have been identified for seven of the eight parks in the Northeast Coastal and Barrier Network. Ozone concentrations are high enough in all eight units to warrant foliar injury surveys. Black cherry and common milkweed are good candidates for foliar injury surveys.

Relevant Websites

NADP - http://nadp.sws.uiuc.edu/
CASTNet - http://www.epa.gov/castnet/
IMPROVE - http://vista.cira.colostate.edu/improve/
Ozone - http://www.epa.gov/air/data/index.html
Pollution sources and air quality data - http://www.epa.gov/air/data/index.html
Pollution sources and monitors (maps and data) - http://www.epa.gov/ttnotag1/areas/

Summary of Ambient Air Quality Data Collected in and near National Park Service Units in the Northeast Coastal and Barrier Network

PARK	NADP/NTN		CASTNet		IMPROVE		OZONE	
	LOCATION	**SITE #**	**LOCATION**	**SITE #**	**LOCATION**	**SITE #**	**LOCATION**	**SITE #**
ASIS	On-site	MD18	Blackwater NWR, MD 55 miles W	BWR139	Edwin B. Forsythe NWR, NJ 90 miles N	BRIG1	Lewes, DE 30 miles N	100051003
					Washington, DC 110 miles NW	WASH1	Seaford, DE 35 miles NW	100051002
CACO	On-site	MA01	Abington, CT 100 miles W	ABT147	On-site	CACO1	On-site	250010002
COLO	Prince Edward County, VA 85 miles W	VA24	Prince Edward County, VA 85 miles W	PED108	Washington, DC 115 miles N	WASH1	Norfolk Airport, VA, 30 miles SE	517100013
	ASIS 110 miles NE	MD18			Swanquarter NWR, NC, 130 miles S	SWAN1	Charles City County, VA, within 30 miles NW	510360002
FIIS	West Point, NY 75 miles NW	NY99	Washington Crossing, NJ 85 miles SW	WSP144	Mohawk Mountain, CT, 80 miles N	MOMO1	Several in Suffolk County. Distances to park unknown.	Several
	Edwin B. Forsythe NWR, NJ, 115 miles S	NJ00			Edwin B. Forsythe NWR, NJ 115 miles S	BRIG1		

GATE	Washington Crossing, NJ 45 miles SW	NJ99	Washington Crossing, NJ 45 miles SW	WSP144	Mohawk Mountain, CT, 85 miles N	MOMO1	Several within 15 miles of the park in Queens, Kings, Richmond (NY) and Monmouth (NJ) Counties	Several
	West Point, NY 55 miles N	NY99			Edwin B. Forsythe NWR, NJ 70 miles S	BRIG1		
	Edwin B. Forsythe NWR, NJ 70 miles S	NJ00						
GEWA	Wye, MD 70 miles NE	MD13	Blackwater NWR, MD 50 miles NE	BWR139	Washington, DC 50 miles N	WASH1	Caroline County, VA, 25 miles SW	510330001
SAHI	West Point, NY 45 miles NW	NY99	Washington Crossing, NJ 80 miles SW	WSP144	Mohawk Mountain, CT, 65 miles N	MOMO1	Nassau County, Eisenhower Park. Distance to park unknown.	360590005
					Edwin B. Forsythe NWR, NJ 105 miles S	BRIG1		
THST	Wye, MD 60 miles NE	MD13	Blackwater NWR, MD 50 miles E	BWR139	Washington, DC 25 miles N	WASH1	Hughesville, MD 10 miles E	240170010

NADP/NTN = National Atmospheric Deposition Program/National Trends Network
CASTNet = Clean Air Status and Trends Network
IMPROVE = Interagency Monitoring of Protected Visual Environments
NWR = U.S. Fish and Wildlife Service National Wildlife Refuge
ASIS = Assateague Island National Seashore
CACO = Cape Cod National Seashore
COLO = Colonial National Historical Park
FIIS = Fire Island National Seashore
GATE = Gateway National Recreation Area
GEWA = George Washington Birthplace National Monument
SAHI = Sagamore Hill National Historic Site
THST = Thomas Stone National Historic Site

PLANT SPECIES VERY SENSITIVE TO OZONE

These species would be expected to produce distinctive foliar injury when exposed to "normal" levels of ambient ozone. This list was developed for the AQUIMS Project and is considered a work in progress. Future updates and changes to this list will be posted to AQUIMS. This version is dated September 20, 1999.

Code	Scientific Name	Common Name	Family
AIAL	Ailanthus altissima	Tree-of-heaven	Simaroubaceae
AMAL2	Amelanchier alnifolia	Saskatoon serviceberry	Rosaceae
APAN2	Apocynum androsaemifolium	Spreading dogbane	Apocynaceae
ARDO3	Artemisia douglasiana	Mugwort	Asteraceae
ASAC6	Aster acuminatus	Whorled aster	Asteraceae
ASEN2	Aster engelmannii	Engelmann's aster	Asteraceae
ASEX	Asclepias exaltata	Tall milkweed	Asclepiadaceae
ASMA2	Aster macrophyllus	Big-leaf aster	Asteraceae
ASPU5	Aster puniceus	Purple-stemmed aster	Asteraceae
ASQU	Asclepias quadrifolia	Four-leaved milkweed	Asclepiadaceae
ASSY	Asclepias syriaca	Common milkweed	Asclepiadaceae
ASUM	Aster umbellatus	Flat-toppped aster	Asteraceae
FRAM2	Fraxinus americana	White ash	Oleaceae
FRPE	Fraxinus pennsylvanica	Green ash	Oleaceae
GEAM4	Gentiana amarella	Northern gentian	Gentianaceae
LIST2	Liquidambar styraciflua	Sweetgum	Hamamelidaceae
LITU	Liriodendron tulipifera	Yellow-poplar	Magnoliaceae
OEEL	Oenothera elata	Evening primrose	Onagraceae
PAQU2	Parthenocissus quinquefolia	Virginia creeper	Vitaceae
PHCA11	Physocarpus capitatus	Ninebark	Rosaceae
PHCO7	Philadelphus coronarius	Sweet mock-orange	Hydrangeaceae
PIJE	Pinus jeffreyi	Jeffrey pine	Pinaceae
PIPO	Pinus ponderosa	Ponderosa pine	Pinaceae
PIPU5	Pinus pungens	Table mountain pine	Pinaceae
PITA	Pinus taeda	Loblolly pine	Pinaceae
PLOC	Platanus occidentalis	American sycamore	Platanaceae
POTR5	Populus tremuloides	Quaking aspen	Salicaceae

PRPE2	Prunus pensylvanica	Pin cherry	Rosaceae
PRSE2	Prunus serotina	Black cherry	Rosaceae
RHCO13	Rhus copallina	Flameleaf sumac	Anacardiaceae
RUAL	Rubus allegheniensis	Allegheny blackberry	Rosaceae
RUHI2	Rudbeckia hirta	Black-eyed susan	Asteraceae
RULA3	Rudbeckia laciniata	Cut-leaf coneflower	Asteraceae
SAAL5	Sassafras albidum	Sassafras	Lauraceae
SACA12	Sambucus canadensis	American elder	Caprifoliaceae
SAME5	Sambucus mexicana	Blue elderberry	Caprifoliaceae
SARA2	Sambucus racemosa	Red elderberry	Caprifoliaceae
SESE2	Senecio serra	Tall butterweed	Asteraceae
VAME	Vaccinium membranaceum	Thin-leaved blueberry	Ericaceae
VILA8	Vitis labrusca	Northern fox grape	Vitaceae

SOURCE: National Park Service, Air Resources Division and Penn State University, Department of Plant Pathology, June 1999

Entered: June 1999

PLANT SPECIES SLIGHTLY SENSITIVE TO OZONE

These species would show distinctive foliar injury only when exposed to “extremely high” levels of ambient ozone. This list was developed for the AQUIMS Project and is considered a work in progress. Future updates and changes to this list will be posted to AQUIMS. This version is dated September 20, 1999.

Code	Scientific Name	Common Name	Family
ACMA3	Acer macrophyllum	Bigleaf maple	Aceraceae
ACNE2	Acer negundo	Boxelder	Aceraceae
ACRU	Acer rubrum	Red maple	Aceraceae
AEGL	Aesculus glabra	Ohio buckeye	Hippocastanaceae
AEOC2	Aesculus octandra	Yellow buckeye	Hippocastanaceae
BEAL2	Betula alleghaniensis	Yellow birch	Betulaceae
BEPO	Betula populifolia	Gray birch	Betulaceae
BRTE	Bromus tectorum	Cheatgrass	Poaceae
CECA4	Cercis canadensis	Redbud	Fabaceae
CLLU	Cladrastis lutea	Yellowwood	Fabaceae
COFL2	Cornus florida	Flowering dogwood	Cornaceae
GLNU	Glyceria nubigena	Manna grass	Poaceae
KRMO	Krigia montana	Mountain dandelion	Asteraceae
LADE2	Larix decidua	European larch	Pinaceae
_LALE0	Larix leptolepis	Japanese larch	Pinaceae
PINI	Pinus nigra	Austrian pine	Pinaceae
PIRA2	Pinus radiata	Monterey pine	Pinaceae
PIRI	Pinus rigida	Pitch pine	Pinaceae
PIVI2	Pinus virginiana	Virginia pine	Pinaceae
RHGL	Rhus glabra	Smooth sumac	Anacardiaceae
RHTR	Rhus trilobata	Skunkbush	Anacardiaceae
RHTY	Rhus typhina	Staghorn sumac	Anacardiaceae
ROPS	Robinia pseudoacacia	Black locust	Fabaceae
RUID	Rubus idaeus	Red raspberry	Rosaceae
RUNU2	Rugelia nudicaulis	Rugel's ragwort	Asteraceae
SAAR13	Saxifraga arguta	Saxifrage	Saxifragaceae

SAGO	Salix gooddingii	Gooding's willow	Salicaceae
SASC	Salix scouleriana	Scouler's willow	Saliaceae
SPVA2	Spiraea x vanhouttei	Vanhoutte spirea	Rosaceae
SYAL	Symphoricarpos albus	Common snowberry	Caprifoliaceae
_SYCHX	Syringa x chinensis	Chinese lilac	Oleaceae
SYVU	Syringa vulgaris	Common lilac	Oleaceae
TIAM	Tilia americana	American basswood	Tiliaceae
_TIEU0	Tilia euchlora	Crimean linden	Tiliaceae
TIPL	Tilia platyphyllos	Bigleaf linden	Tiliaceae
TORA2	Toxicodendron radicans	Poison-ivy	Anacardiaceae
VEOC	Verbesina occidentalis	Crownbeard	Asteraceae
VICA5	Vitis californica	California grape	Vitaceae
VIGI2	Vitis girdiana	Wild grape	Vitaceae
VIRI	Vitis riparia	Riverbank grape	Vitaceae
VIVI5	Vitis vinifera	European wine grape	Vitaceae

Note: A code, such as _LALE0, which is preceded by an underscore indicates that the code is tentative and was created for the purpose of referencing the species. An NRCS PLANTS database code does not yet exist for the given species.

SOURCE: National Park Service, Air Resources Division and Penn State University, Department of Plant Pathology, December 1998

Entered: 1999

NORTHEAST COASTAL AND BARRIER NETWORK
OZONE-SENSITIVE VASCULAR PLANT SPECIES
(from NPSpecies)
April 2002

Assateague Island NS

Scientific Name	Common Name	Family
Ailanthus altissima	Tree-of-heaven	Simaroubaceae
Asclepias syriaca	Common milkweed	Asclepiadaceae
Liquidambar styraciflua	Sweetgum	Hamamelidaceae
Liriodendron tulipifera	Yellow-poplar	Magnoliaceae
Parthenocissus quinquefolia	Virginia creeper	Vitaceae
Pinus taeda	Loblolly pine	Pinaceae
Platanus occidentalis	American sycamore	Platanaceae
Prunus serotina	Black cherry	Rosaceae
Rhus copallina	Flameleaf sumac	Anacardiaceae
Rubus allegheniensis	Allegheny blackberry	Rosaceae
Sambucus canadensis	American elder	Caprifoliaceae
Sassafras albidum	Sassafras	Lauraceae

Cape Cod NS

Scientific Name	Common Name	Family
Ailanthus altissima	Tree-of-heaven	Simaroubaceae
Apocynum androsaemifolium	Spreading dogbane	Apocynaceae
Asclepias syriaca	Common milkweed	Asclepiadaceae
Parthenocissus quinquefolia	Virginia creeper	Vitaceae
Populus tremuloides	Quaking aspen	Salicaceae
Prunus pensylvanica	Pin cherry	Rosaceae
Prunus serotina	Black cherry	Rosaceae
Rhus copallina	Flameleaf sumac	Anacardiaceae
Rubus allegheniensis	Allegheny blackberry	Rosaceae
Rudbeckia hirta	Black-eyed susan	Asteraceae
Sambucus canadensis	American elder	Caprifoliaceae
Sassafras albidum	Sassafras	Lauraceae
Vitis labrusca	Northern fox grape	Vitaceae

Colonial NHP

Scientific Name	Common Name	Family
Ailanthus altissima	Tree-of-heaven	Simaroubaceae
Asclepias syriaca	Common milkweed	Asclepiadaceae
Fraxinus americana	White ash	Oleaceae
Fraxinus pennsylvanica	Green ash	Oleaceae
Liquidambar styraciflua	Sweetgum	Hamamelidaceae
Liriodendron tulipifera	Yellow-poplar	Magnoliaceae
Parthenocissus quinquefolia	Virginia creeper	Vitaceae
Pinus taeda	Loblolly pine	Pinaceae
Platanus occidentalis	American sycamore	Platanaceae
Populus tremuloides	Quaking aspen	Salicaceae
Prunus serotina	Black cherry	Rosaceae
Rhus copallina	Flameleaf sumac	Anacardiaceae
Rubus allegheniensis	Allegheny blackberry	Rosaceae
Rudbeckia hirta	Black-eyed susan	Asteraceae
Sambucus canadensis	American elder	Caprifoliaceae
Sassafras albidum	Sassafras	Lauraceae
Vitis labrusca	Northern fox grape	Vitaceae

Fire Island NS

Scientific Name	Common Name	Family
Ailanthus altissima	Tree-of-heaven	Simaroubaceae
Asclepias syriaca	Common milkweed	Asclepiadaceae
Fraxinus americana	White ash	Oleaceae
Liquidambar styraciflua	Sweetgum	Hamamelidaceae
Parthenocissus quinquefolia	Virginia creeper	Vitaceae
Platanus occidentalis	American sycamore	Platanaceae
Populus tremuloides	Quaking aspen	Salicaceae
Prunus serotina	Black cherry	Rosaceae
Rhus copallina	Flameleaf sumac	Anacardiaceae
Rubus allegheniensis	Allegheny blackberry	Rosaceae
Rudbeckia hirta	Black-eyed susan	Asteraceae
Sambucus canadensis	American elder	Caprifoliaceae
Sassafras albidum	Sassafras	Lauraceae
Vitis labrusca	Northern fox grape	Vitaceae

Gateway NRA

Scientific Name	Common Name	Family
Ailanthus altissima	Tree-of-heaven	Simaroubaceae
Asclepias syriaca	Common milkweed	Asclepiadaceae
Fraxinus americana	White ash	Oleaceae
Fraxinus pennsylvanica	Green ash	Oleaceae
Liquidambar styraciflua	Sweetgum	Hamamelidaceae
Liriodendron tulipifera	Yellow-poplar	Magnoliaceae
Parthenocissus quinquefolia	Virginia creeper	Vitaceae
Philadelphus coronarius	Sweet mock-orange	Hydrangeaceae
Platanus occidentalis	American sycamore	Platanaceae
Populus tremuloides	Quaking aspen	Salicaceae
Prunus pennsylvanica	Pin cherry	Rosaceae
Prunus serotina	Black cherry	Rosaceae
Rhus copallina	Flameleaf sumac	Anacardiaceae
Rubus allegheniensis	Allegheny blackberry	Rosaceae
Rudbeckia hirta	Black-eyed susan	Asteraceae
Sambucus canadensis	American elder	Caprifoliaceae
Sassafras albidum	Sassafras	Lauraceae
Vitis labrusca	Northern fox grape	Vitaceae

George Washington Birthplace NM

Scientific Name	Common Name	Family
Asclepias syriaca	Common milkweed	Asclepiadaceae
Liquidambar styraciflua	Sweetgum	Hamamelidaceae
Liriodendron tulipifera	Yellow-poplar	Magnoliaceae
Parthenocissus quinquefolia	Virginia creeper	Vitaceae
Pinus taeda	Loblolly pine	Pinaceae
Platanus occidentalis	American sycamore	Platanaceae
Prunus serotina	Black cherry	Rosaceae
Rhus copallina	Flameleaf sumac	Anacardiaceae
Rudbeckia hirta	Black-eyed susan	Asteraceae
Sambucus canadensis	American elder	Caprifoliaceae
Vitis labrusca	Northern fox grape	Vitaceae

Sagamore Hill NHS

Scientific Name	Common Name	Family
Asclepias syriaca	Common milkweed	Asclepiadaceae
Liriodendron tulipifera	Yellow-poplar	Magnoliaceae
Parthenocissus quinquefolia	Virginia creeper	Vitaceae
Prunus serotina	Black cherry	Rosaceae
Rhus copallina	Flameleaf sumac	Anacardiaceae
Rubus allegheniensis	Allegheny blackberry	Rosaceae
Rudbeckia hirta	Black-eyed susan	Asteraceae
Sambucus canadensis	American elder	Caprifoliaceae
Sassafras albidum	Sassafras	Lauraceae